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Michelle R. Burns

TORQUE-BASED OCCUPANT WEIGHT  
ESTIMATION APPARATUS FOR A VEHICLE SEAT

5    Technical Field

This invention is directed to apparatus for detecting the weight of an occupant of a motor vehicle seat for purposes of determining whether and how forcefully to deploy supplemental restraints, and more particularly to apparatus for measuring forces applied to a frame of the vehicle seat.

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Background of the Invention

Vehicle occupant detection systems are useful in connection with air bags and other pyrotechnically deployed restraints as a means of judging whether, and how forcefully, to deploy the restraint. One fundamental 15 parameter in this regard is the weight of the occupant, as weight may be used as a criterion to distinguish between an adult and an infant or small child.

Most prior weight estimation techniques involve installing a pressure sensitive element such as a variable resistance pad or a fluid-filled bladder in or under a vehicle seat cushion, and utilizing the pressure measurement as an 20 indication of occupant weight. See, for example, the U.S. Patent Nos. 5,474,327, 5,987,370, 6,246,936, 6,101,436 and 6,490,936.

Alternatively, the occupant weight may be measured with one or more strain gauges or load cells that sense the forces (strain or pressure) that the seat applies to a bracket that supports the seat on the vehicle floor. See, for example, 25 the U.S. Patent No. 5,942,695 and the Publication Nos. 41520, 41542, 41549 and 41559 from the November, 1998 issue of Research Disclosure.

Summary of the Invention

The present invention is directed to a torque-based occupant weight 30 estimation apparatus for a vehicle seat, where the seat frame is coupled to a set of floor brackets through front and rear torsion bars. The torsion bars are

rotatably mounted on the floor brackets, and linkage arms rigidly coupled to opposing ends of each torsion bar are rotatably coupled to the seat frame so as to convert occupant seat weight into torsion bar torque. Torque sensors coupled to the torsion bars provide an indication of occupant weight.

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#### Brief Description of the Drawings

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a side-view diagram of a vehicle seat incorporating the  
10 torque-based occupant weight estimation apparatus of the present invention,  
with portions of the seat frame removed to illustrate the operation of the  
invention.

Figure 2 is a top view of the apparatus of Figure 1, with the seat and seat  
frame removed.

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#### Description of the Preferred Embodiment

Referring to Figures 1-2, the reference numeral 10 generally designates a vehicle seat, including seat and backrest cushions 10a, 10b supported on a frame 12. The frame 12 rides on a pair of laterally spaced seat tracks 14, 16; the tracks 20 14, 16 are coupled to respective floor brackets (also known as risers) 18, 20 through front and rear torsion bars 22, 24, and the floor brackets 18, 20 are bolted to the vehicle floor 26. The front and rear torsion bars 22, 24 are rotatably supported by the floor brackets 18, 20, via a set of inboard downwardly depending flanges 18a, 18b; 20a, 20b, and a set of four linkage 25 arms 28, 30, 32, 34 couple the seat tracks 14, 16 to the torsion bars 22, 24. The linkage arms 28, 30, 32, 34 are welded (or otherwise rigidly secured) to the respective torsion bars 22, 24, but rotatably coupled to the respective seat tracks 14, 16 so that occupant weight applied to seat 10 imparts a corresponding overall torque to the torsion bars 22, 24. The linkage arms 28, 30, 32, 34 are 30 disposed oppositely about the respective torsion bars 22, 24 so that the imparted torques are additive. For example, the linkage arm 28 is disposed forward of the

torsion bar 22 to impart counter-clockwise torque, and the opposing linkage arm 30 is disposed rearward of the torsion bar 22 to impart clockwise torque. The torques imparted to torsion bar 22 by the linkage arms 28 and 30 are measured by the torque sensor 36 disposed between the linkage arms 28 and 30, and the 5 torques imparted to torsion bar 24 by the linkage arms 32 and 34 are measured by the torque sensor 38 disposed between the linkage arms 32 and 34. The torque sensors 36 and 38 are preferably magneto-elastic torque sensors such as manufactured by Magnetoelastic Devices, Inc., Pittsfield, Massachusetts, but other sensors responsive to the imparted torques may also be used. The torque 10 signals produced by sensors 36 and 38 are applied as inputs to control unit 40 via lines 42 and 44; the controller 40 sums the measured torques to develop an indication of occupant weight or weight classification for purposes of deciding whether and how forcefully to deploy supplemental restraints designed to protect the occupant from serious injury in a crash event, and produces a 15 corresponding output on line 46.

In summary, the present invention provides a seat frame-based occupant weight estimation apparatus including front and rear torsion bars 22, 24 and a set of linkage arms 28, 30, 32, 34 that translate vertical force associated with occupant weight to torsion bar torques that are sensed by a torque sensors 36, 20 38. While illustrated with respect to the illustrated embodiments, it will be recognized that various modifications in addition to those mentioned above may occur to those skilled in the art. For example, the linkage arms 28, 30, 32, 34 could be located inboard of the seat tracks 14, 16, and so on. Accordingly, it will be understood that devices incorporating these and other modifications may fall 25 within the scope of this invention, which is defined by the appended claims.